



# Shower-base Calibration

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# Plan from last meeting

✓ complète

## ► Refine data selection:

- Reject 12 ang 16 GeV data for calibration due to narrow beam spot? (avoid coupling between beam position and calibration)

✓ complète

## ► Refine constrains and tail rejections

- Online calibration: 3 iteration of with tightening tail rejection
- This trial: 1 iteration without rejecting tails

In eval

## ► Apply calibration to test production and quantify resolution with analysis hodo-scope cuts

✓ complète

## ► Treatment of towers with no calibration data (but used in hadron data)

- Expect reuse MIP calibration with some average re-scaling

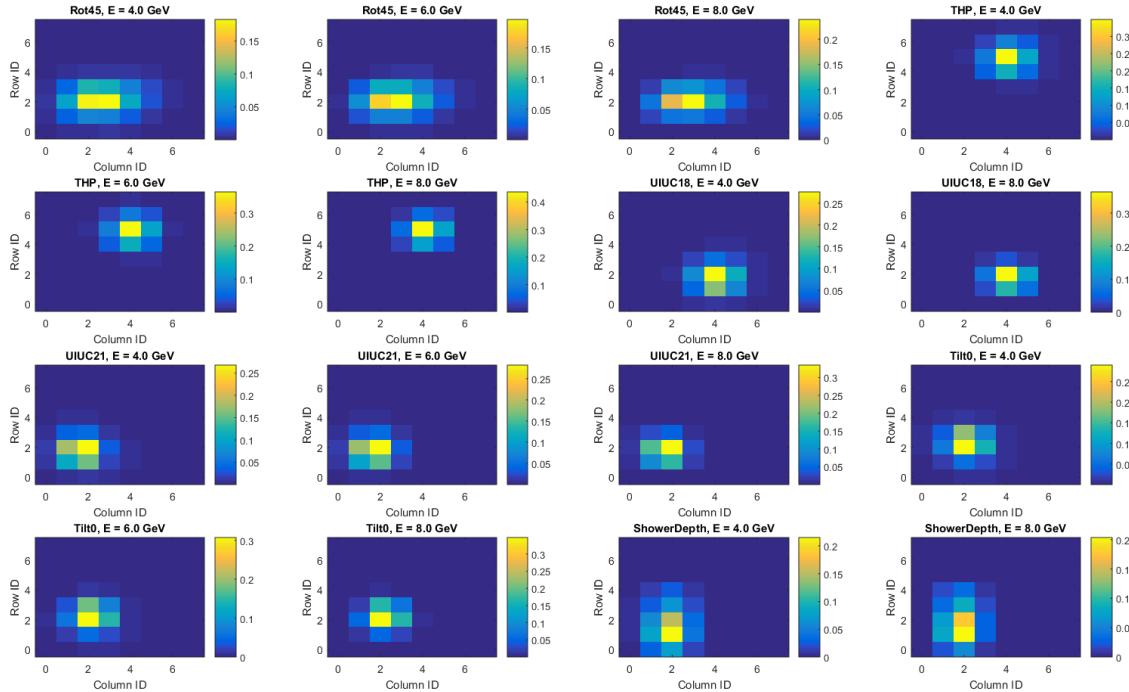
# Shower calibration

- ▶ Preselection
  - Use four configurations of detector setup with data sets of various beam energy to cover max number of towers
  - Use temperature correction (inc. current unresolved mapping error) – quoting number from last presentation of Joey and Martin
- ▶ Step1: Analysis modules on GitHub, and special cut for calibration  
<https://github.com/sPHENIX-Collaboration/analysis/tree/master/Prototype2/EMCal/ShowerCalib>
  - No hit in veto counter (Calib E < 15)
  - Valid single hodo-scope fired in H / V (Calib E > 30), accept all 8x8 hodo-scope fingers
  - Electron Cherenkov (sum c2 > 100)
  - Temperature is not crazy (25C < T < 30C)
  - Energy sum using all 5x5 towers clusters (max cluster over 8x8)
- ▶ Step2: Calibration code in matlab
  - Objective function = Sum  $((E_{\text{observ}} - E_{\text{expect}})/\sigma(E))^2$  is minimal
  - Allow energy scale ( $E_{\text{expect}}$ ) to vary from each configuration
- ▶ Step3: Apply shower calibration to redo resolution plots
- ▶ Step4: Fit for linearity and resolution.
  - Use +/-2sigma window for resolution Gauss fits

# Code base

- ▶ Fun4All analysis module: (step1, and again in step3)
  - Perform event selection, clusterizing, temperature correction, make histograms, calibration and evaluation ROOT file
  - C++Module: <https://github.com/sPHENIX-Collaboration/analysis/tree/master/Prototype2/EMCal/ShowerCalib>
  - Fun4All macro: [https://github.com/sPHENIX-Collaboration/analysis/blob/master/Prototype2/EMCal/macros/Fun4All\\_TestBeam\\_ShowerCalib.C](https://github.com/sPHENIX-Collaboration/analysis/blob/master/Prototype2/EMCal/macros/Fun4All_TestBeam_ShowerCalib.C)
- ▶ Matlab optimization code (step2)
  - <https://github.com/sPHENIX-Collaboration/analysis/tree/master/Prototype2/EMCal/ShowerCalib/Fit>
- ▶ Plot (step4)
  - <https://github.com/sPHENIX-Collaboration/analysis/blob/master/Prototype2/EMCal/macros/DrawPrototype2ShowerCalib.C>

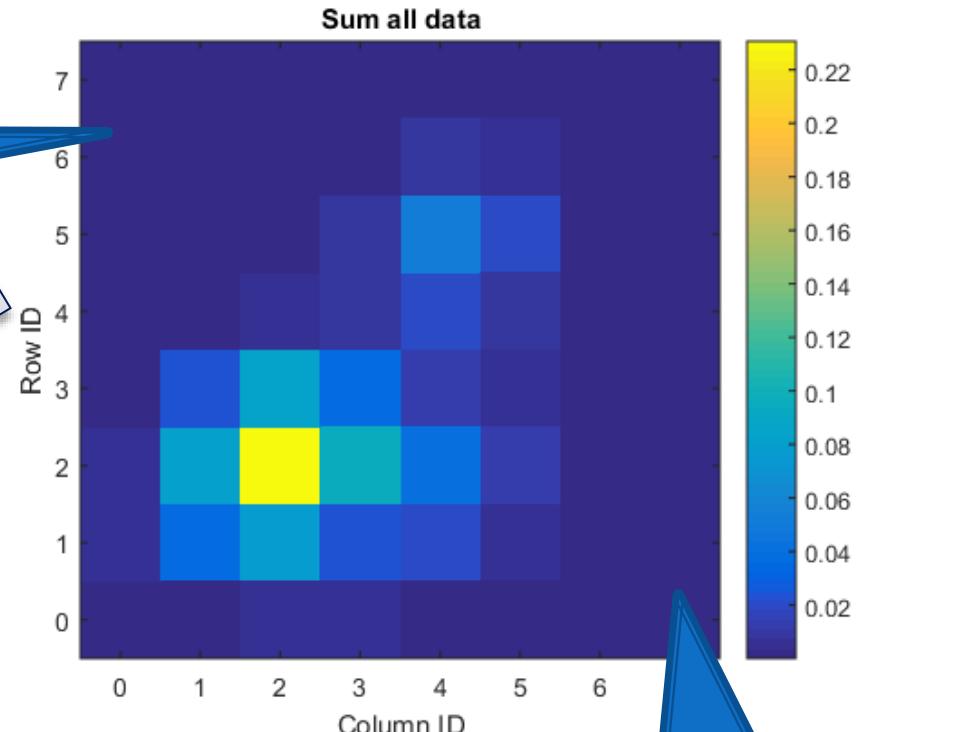
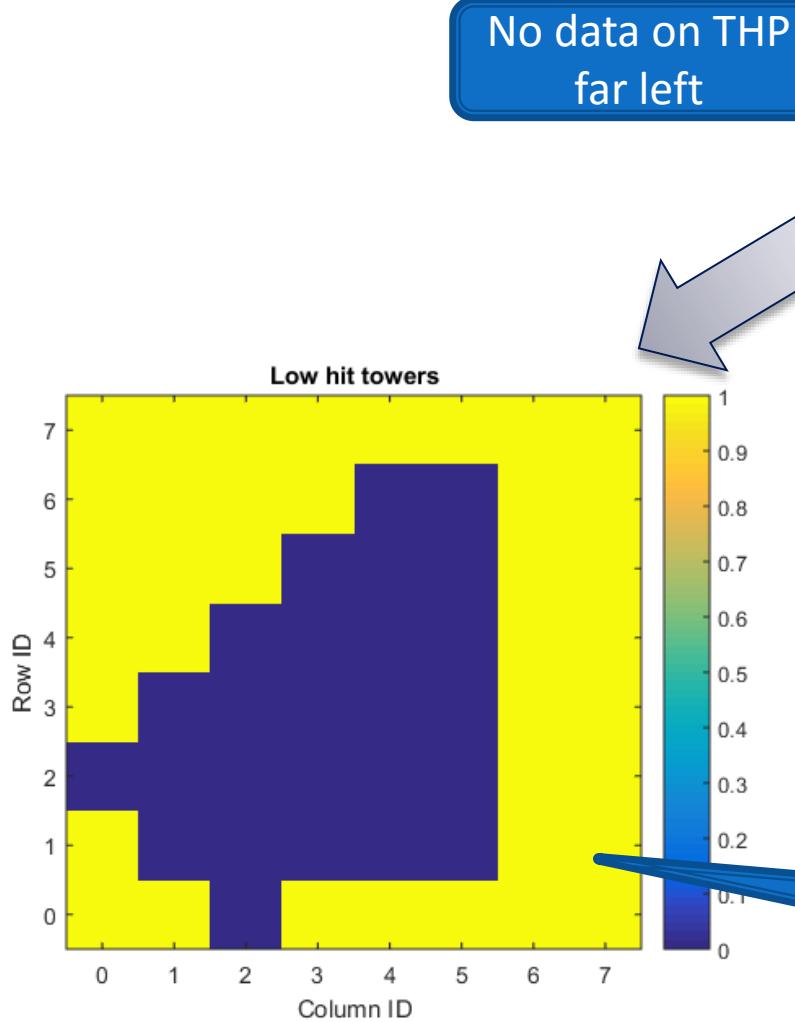
# Data sets 1 of 2: Inspect each data sets



Run numbers as linked to wiki

- [https://wiki.bnl.gov/sPHENIX/index.php/T-1044/EMCal\\_good\\_run\\_note#Energy\\_Scan\\_.280\\_Degree\\_tilt.2C\\_EMCal\\_rotated\\_45\\_Degree.29](https://wiki.bnl.gov/sPHENIX/index.php/T-1044/EMCal_good_run_note#Energy_Scan_.280_Degree_tilt.2C_EMCal_rotated_45_Degree.29)
- [https://wiki.bnl.gov/sPHENIX/index.php/T-1044/EMCal\\_good\\_run\\_note#Energy\\_Scan\\_.28THP\\_centered.2C\\_Tower\\_42.2C\\_70k\\_Events.29](https://wiki.bnl.gov/sPHENIX/index.php/T-1044/EMCal_good_run_note#Energy_Scan_.28THP_centered.2C_Tower_42.2C_70k_Events.29)
- UIUC runs centered on block 18
- [https://wiki.bnl.gov/sPHENIX/index.php/T-1044/EMCal\\_good\\_run\\_note#Energy\\_Scan\\_.28UIUC\\_centered.2C\\_Tower\\_21.2C\\_350k\\_Events.29](https://wiki.bnl.gov/sPHENIX/index.php/T-1044/EMCal_good_run_note#Energy_Scan_.28UIUC_centered.2C_Tower_21.2C_350k_Events.29)
- [https://wiki.bnl.gov/sPHENIX/index.php/T-1044/joint\\_data\\_good\\_run\\_note#Final\\_Energy\\_Scan\\_.280\\_Degree\\_tilt.2C\\_EMCal\\_facing\\_upstream.29](https://wiki.bnl.gov/sPHENIX/index.php/T-1044/joint_data_good_run_note#Final_Energy_Scan_.280_Degree_tilt.2C_EMCal_facing_upstream.29)
- [https://wiki.bnl.gov/sPHENIX/index.php/T-1044/EMCal\\_good\\_run\\_note#Shower\\_depth\\_scan](https://wiki.bnl.gov/sPHENIX/index.php/T-1044/EMCal_good_run_note#Shower_depth_scan)

# Data sets 2 of 2: Sum all data sets

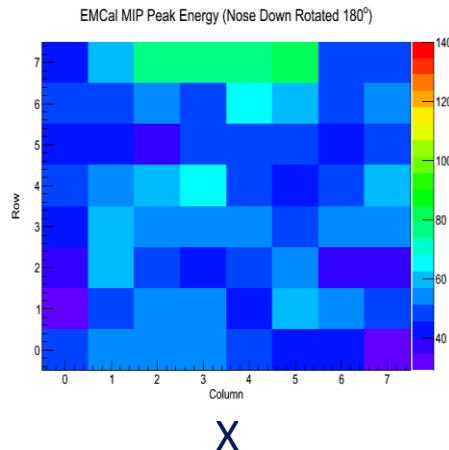


Mask of towers of no shower calibration

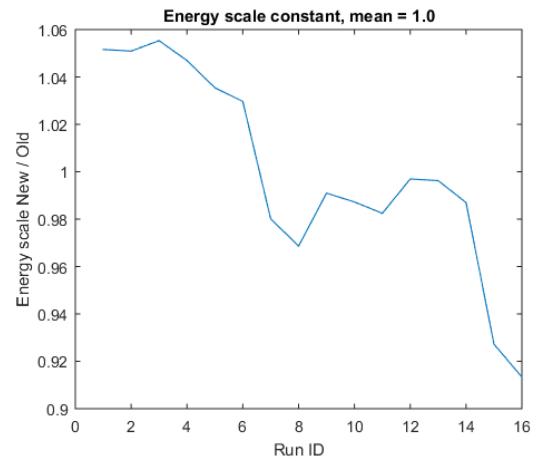
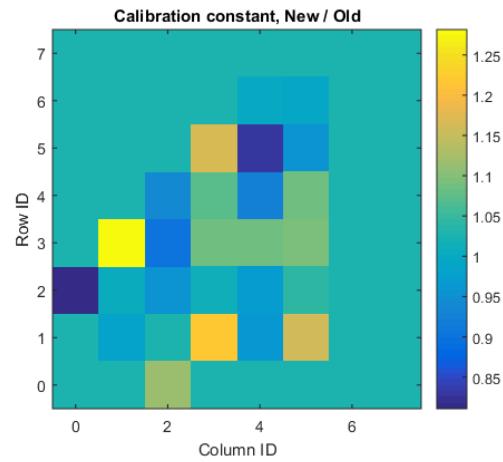
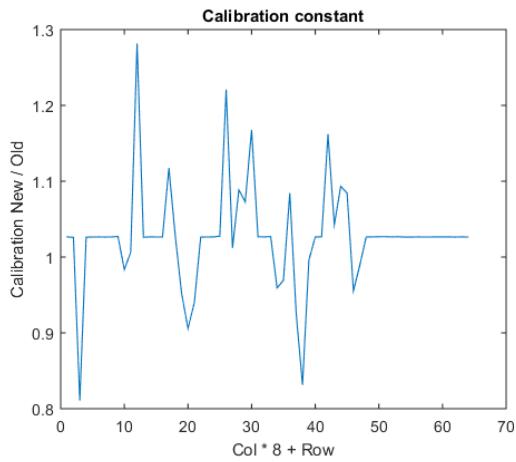
No data on UIUC far right

# New calibration constant

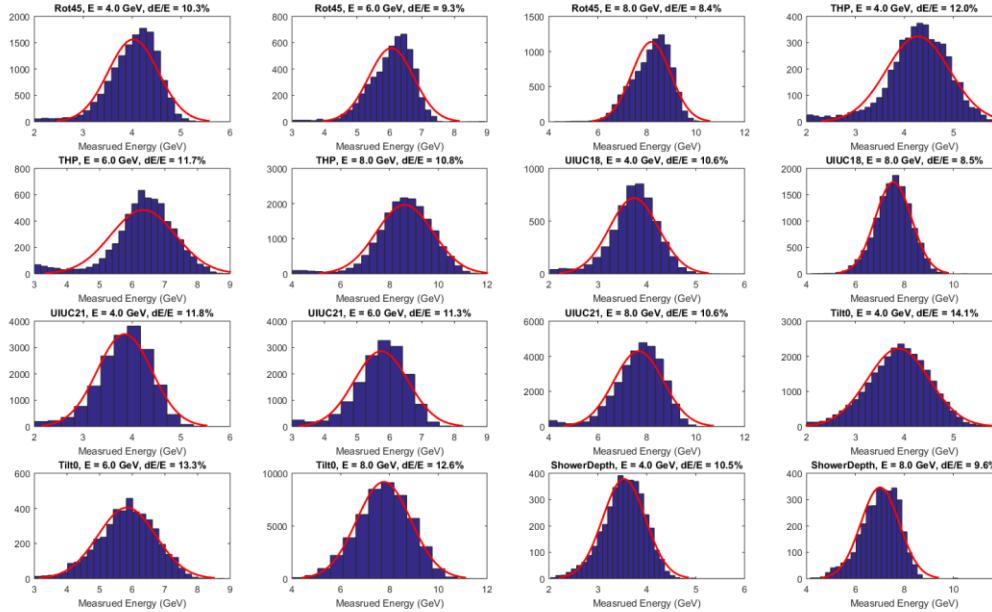
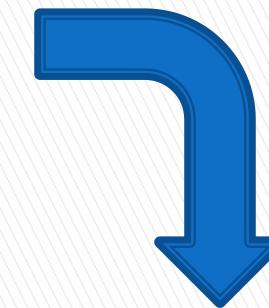
Mike's set 2:



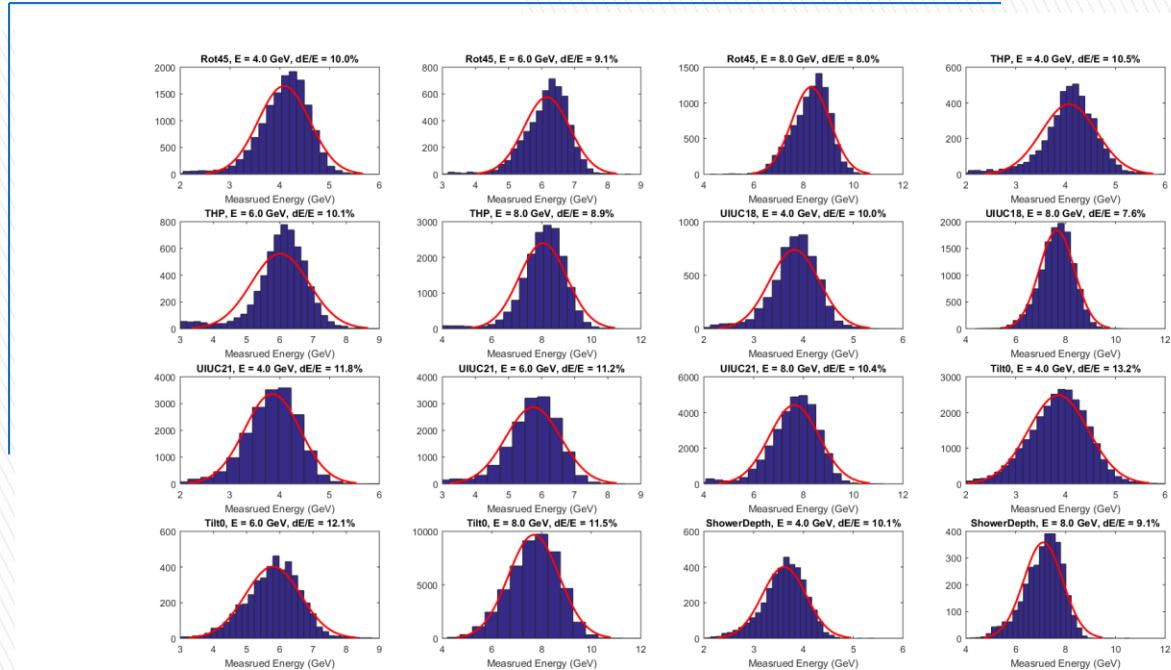
X



# A trial run

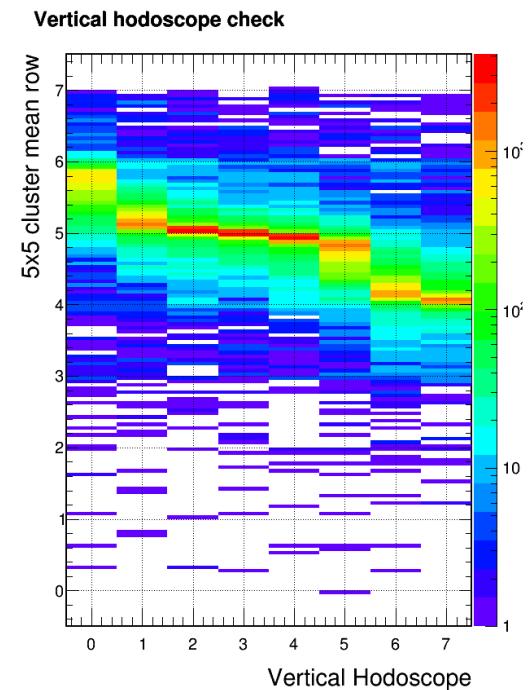
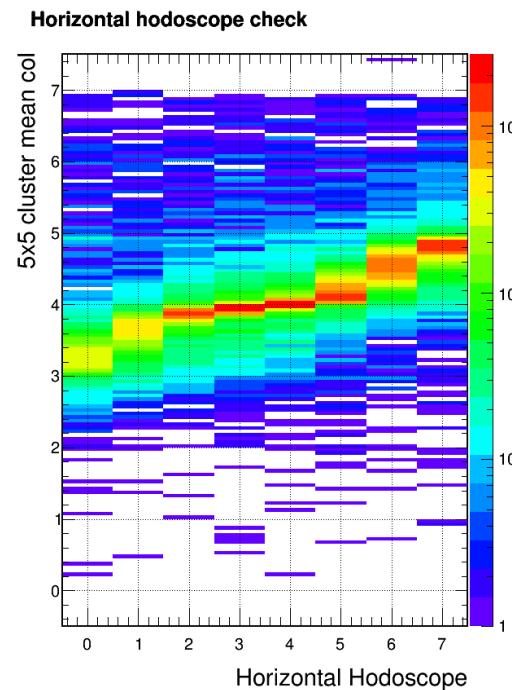
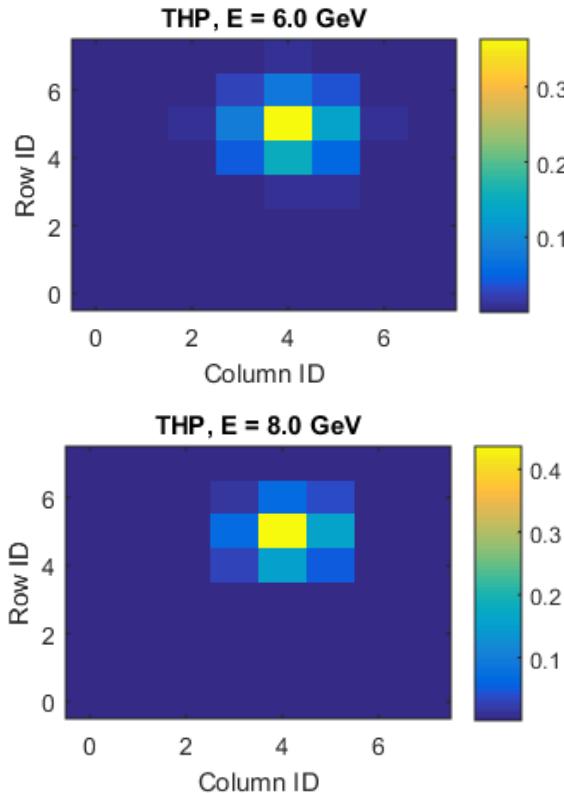


- General improvement in spread in all data sets
- Significant tail remains for 45 degree tilted configuration
- THP somehow has better over resolution (note accepting 8x8 hodoscope here). From higher density variation?
- Not as dramatic improvement for UIUC first high statistics scan on tower 21, but improves in the final scans on tower 21

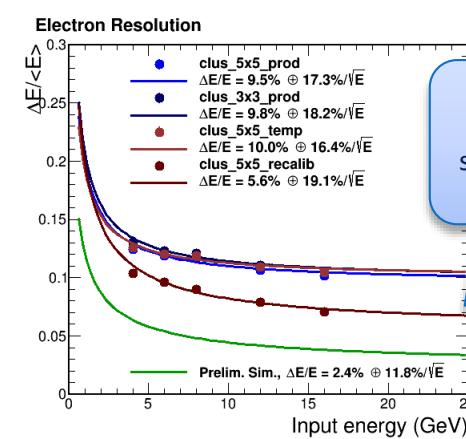
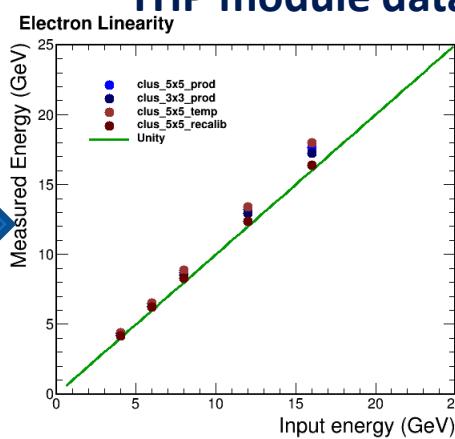
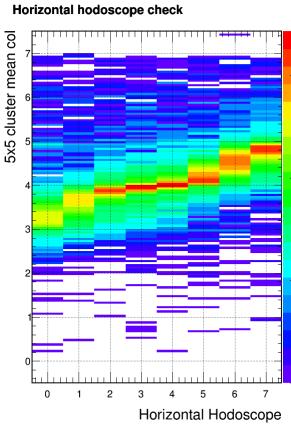


# Apply to THP module data

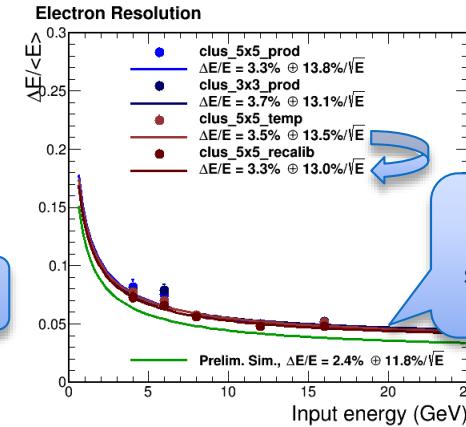
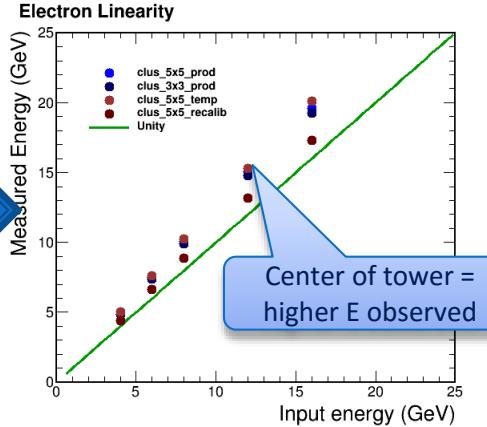
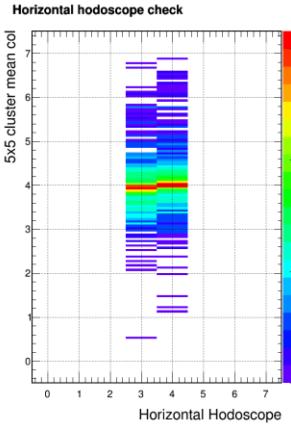
[https://wiki.bnl.gov/sPHENIX/index.php/T-1044/EMCal\\_good\\_run\\_note#Energy\\_Scan\\_.28THP\\_centered.2C\\_Tower\\_42.2C\\_70k\\_Events.29](https://wiki.bnl.gov/sPHENIX/index.php/T-1044/EMCal_good_run_note#Energy_Scan_.28THP_centered.2C_Tower_42.2C_70k_Events.29)



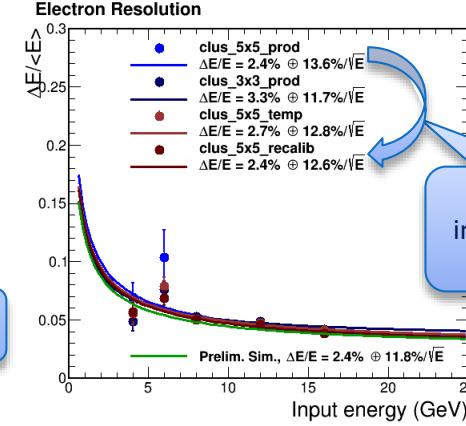
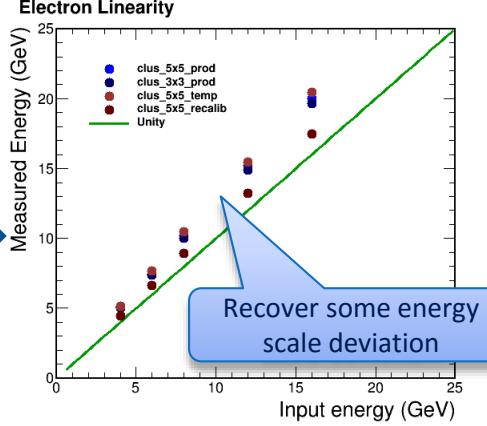
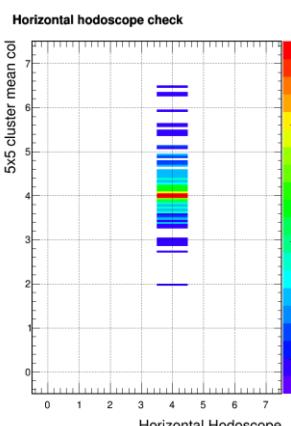
# THP module data!



Effect of shower calibration when shower cover many towers



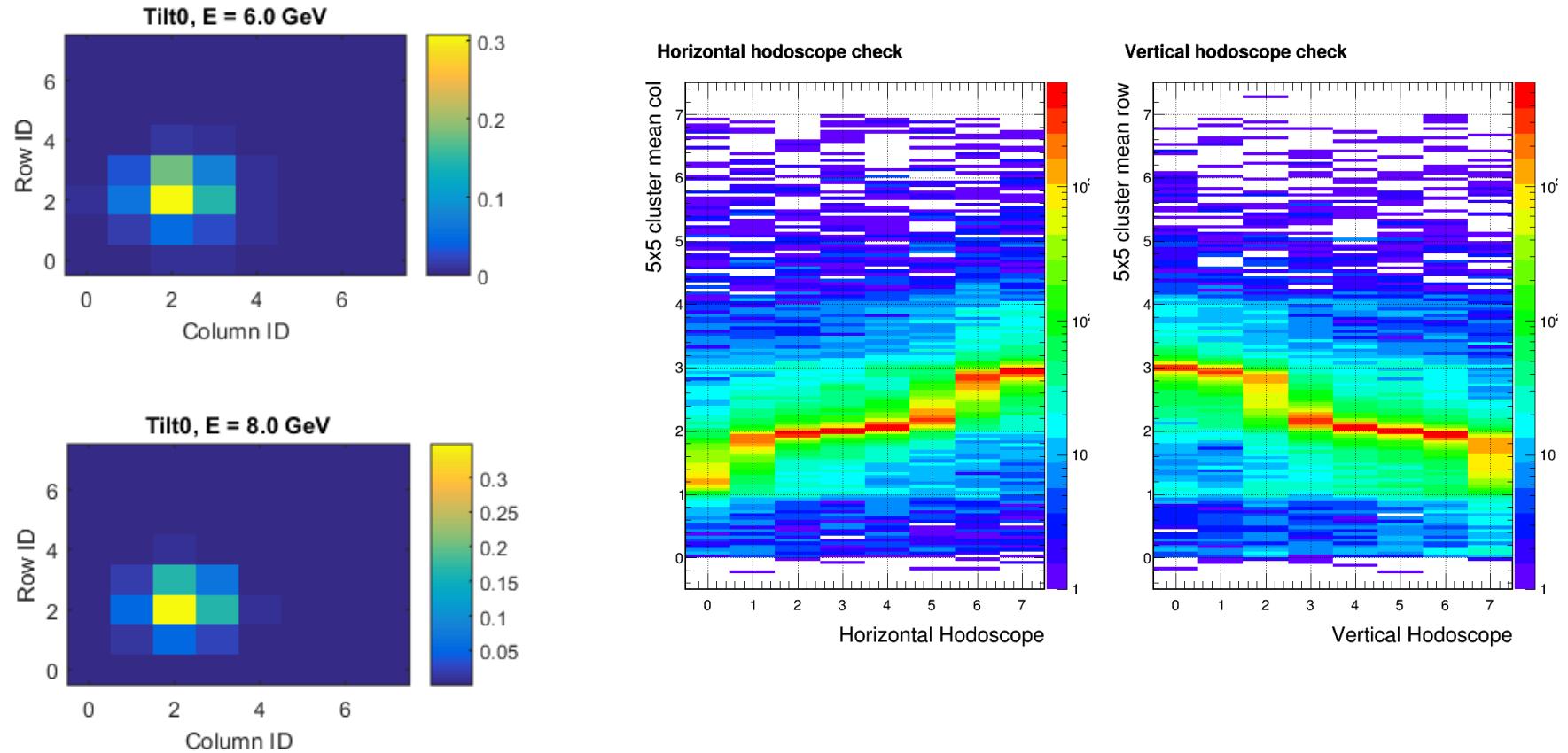
Everything behave similarly when shower around the center of tower

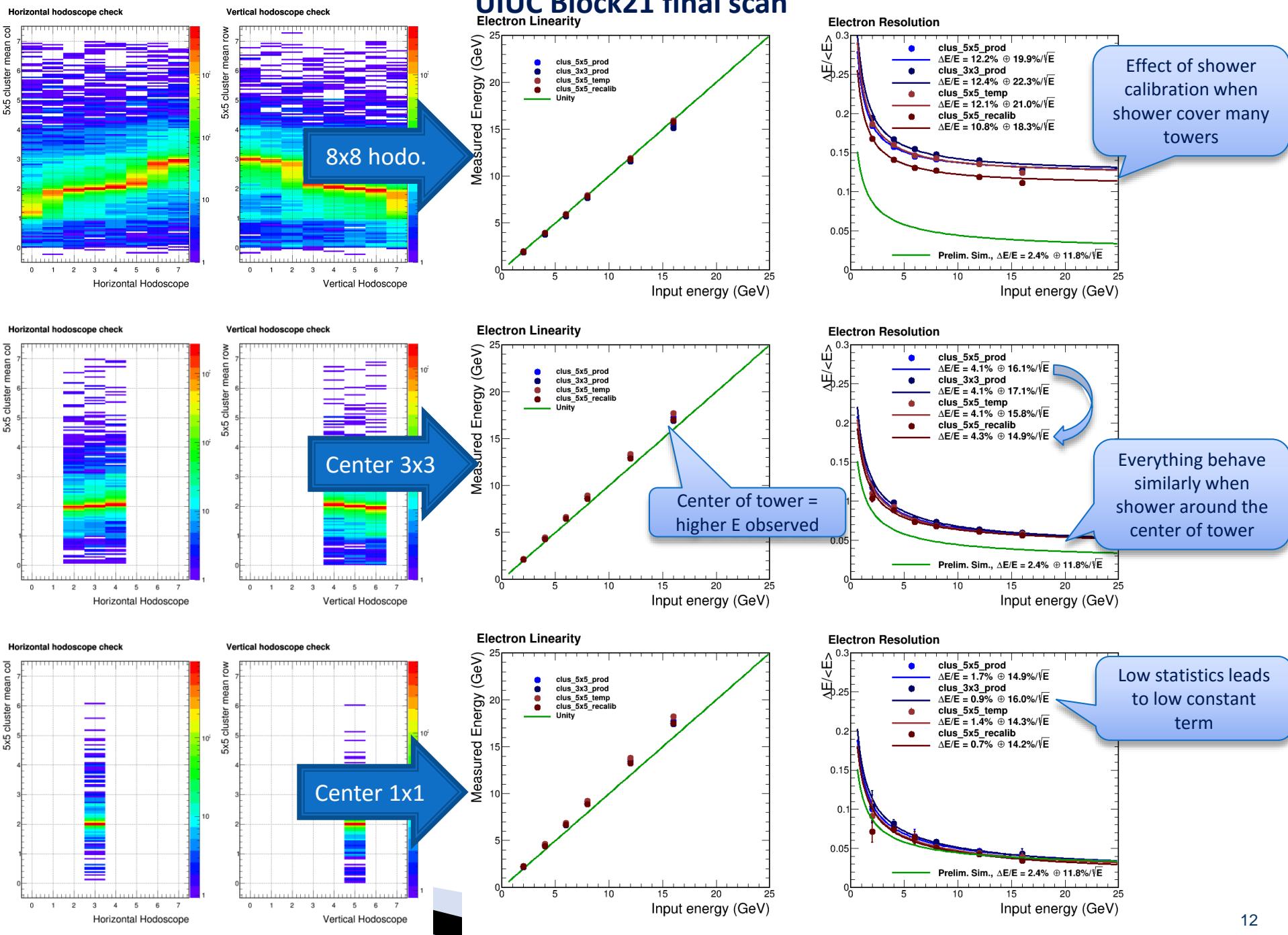


Shower calib improve ~1% in stat term

# Apply to Final Energy Scan, 0 tilt

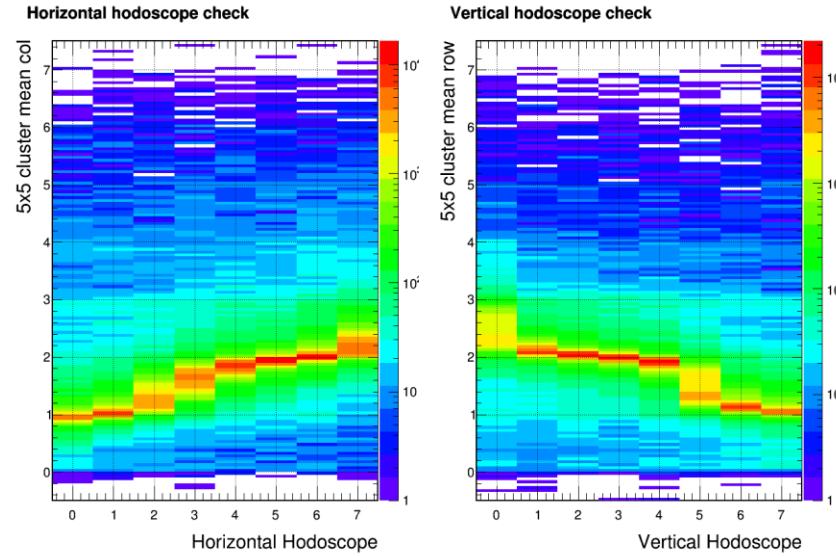
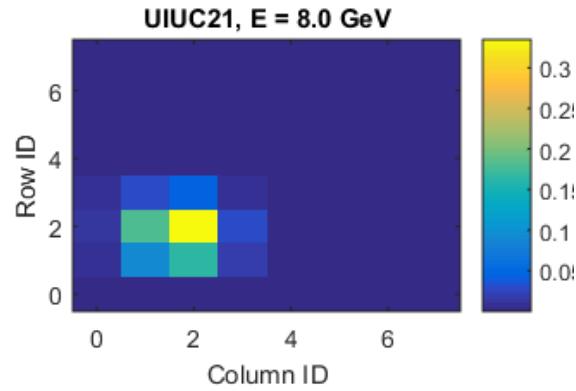
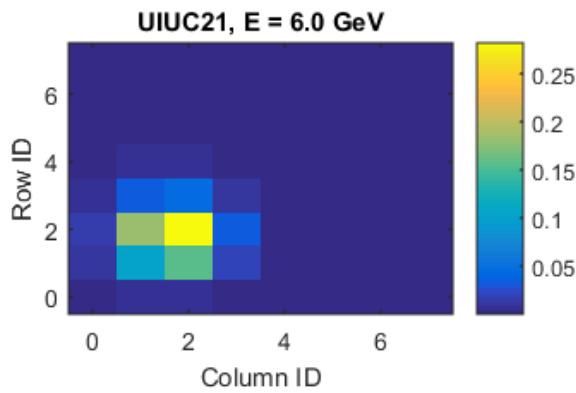
[https://wiki.bnl.gov/sPHENIX/index.php/T-1044/joint\\_data\\_good\\_run\\_note#Final\\_Energy\\_Scan\\_.280\\_Degree\\_tilt.2C\\_EMCal\\_facing\\_upstream.29](https://wiki.bnl.gov/sPHENIX/index.php/T-1044/joint_data_good_run_note#Final_Energy_Scan_.280_Degree_tilt.2C_EMCal_facing_upstream.29)



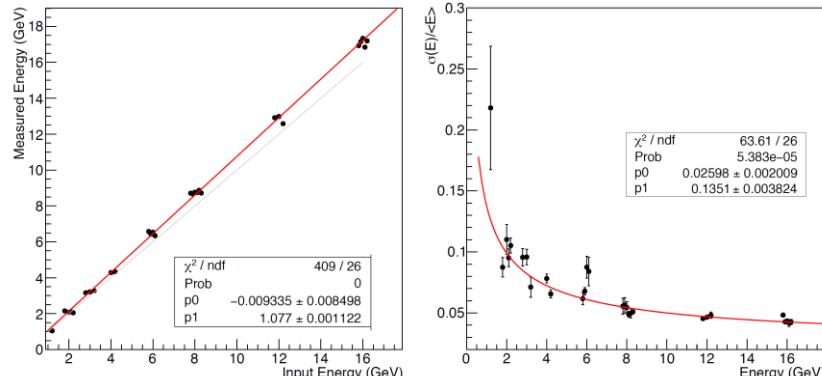


# Apply to high statistics block21 scan

[https://wiki.bnl.gov/sPHENIX/index.php/T-1044/EMCal\\_good\\_run\\_note#Energy\\_Scan\\_.28UIUC\\_centered.2C\\_Tower\\_21.2C\\_350k\\_Events.29](https://wiki.bnl.gov/sPHENIX/index.php/T-1044/EMCal_good_run_note#Energy_Scan_.28UIUC_centered.2C_Tower_21.2C_350k_Events.29)

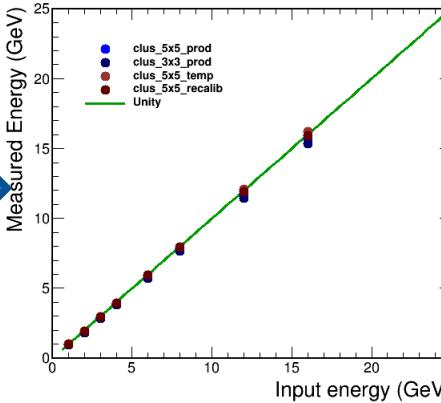


Virginia Bailey (University of Illinois), Dr. Vera Loggins (University of Illinois Urbana Champaign), in 2x1 horoscope finger selection



# UIUC Block21 high statistics scan

## Electron Linearity

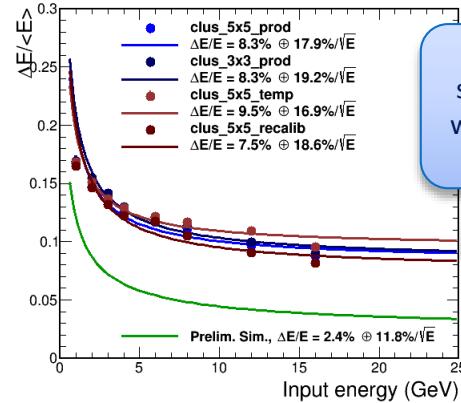


Vertical hodoscope check

Horizontal hodoscope check

8x8 hodo.

## Electron Resolution



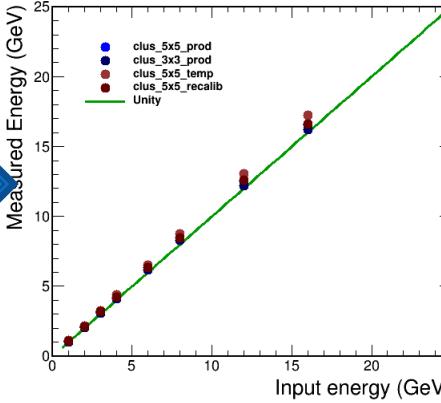
Minor effect of shower calibration when shower cover many towers

Vertical hodoscope check

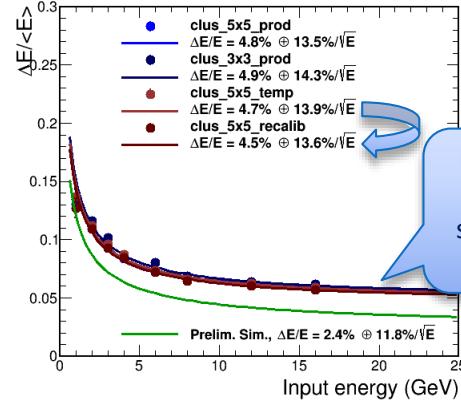
Horizontal hodoscope check

Center 3x3

## Electron Linearity



## Electron Resolution



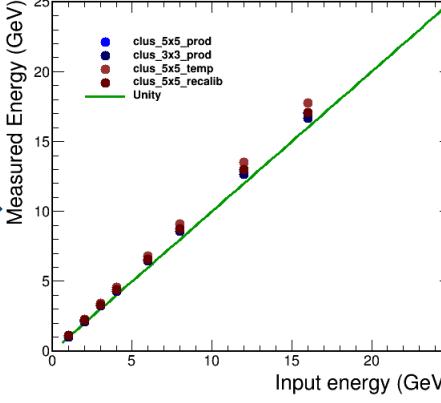
Everything behave similarly when shower around the center of tower

Vertical hodoscope check

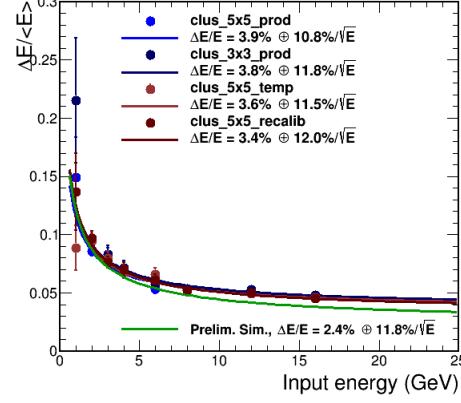
Horizontal hodoscope check

Center 1x1

## Electron Linearity



## Electron Resolution



# Conclusion

- ▶ Resolution is highly position and hodoscope cut-size dependent
- ▶ Shower based calibration improve resolution more dramatically when shower center spreads over many modules
- ▶ When shower hit center of THP module, the improvement is ~1% in statistical term. Some minor improve in other cases too
- ▶ In the center, all cases looks similar.
  - THP modules provide good resolution too: 2.4% constant term + 12.6%/VE statistical term
- ▶ Caveats: current temperature correction still has the mapping issue reported my Martin last time.